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MINING, TREATMENT, METHODS, AND COSTS AT THE EAST TEXAS GRAVEL CO.'S DEPOSITS NEAR BOIS D'ARC, TEX.

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WALTER W. HYDE

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MINING, TREATMENT METHODS, AND COSTS AT THE EAST TEXAS GRAVEL COMPANY'S DEPOSITS NEAR BOIS D'ARC, TEX.[1]

By Walter W. Hyde[2]

INTRODUCTION

This paper describing the mining and preparation of sand and gravel for a number of special markets by the East Texas Gravel Co., Dallas, Tex., is one of a series being prepared on the subject by the United States Bureau of Mines.

These articles are designed to disseminate technical information regarding the methods used. The cost tabulations represent operating expenditures only and not total production costs. It is recognized that publication of total production costs might in many instances cause embarrassment to individual producers as well as to the industry as a whole, but on the other hand, operating costs are essential to the technical discussion and study of the methods employed. The attention of the reader is specifically called to this differentiation in order that no misunderstanding of the scope of the cost tabulations shall ensue.

Operators of sand and gravel deposits who have a surplus of sand and small pebbles which must be sent to waste will be particularly interested in the description of equipment and the method of removing these waste materials near the excavating machine in the pit, while mining.

The gravel deposits are located in the southwestern part of Kaufman County about 20 miles southeasterly from Dallas and approximately 5 miles south of the main line of the Texas and New Orleans Railroad (Southern Pacific Lines), at Bois D'Arc. From this point a standard-gage railroad track has been constructed, connecting the main line with the loading tracks at the deposits.

ACKNOWLEDGMENTS

In the preparation of this paper the author wishes to acknowledge the assistance of J. R. Thoenen, mining engineer of the United States Bureau of Mines, and the officials of the East Texas Gravel Co. The author also wishes to express his gratitude to G. A. Parkinson, of the University of Texas, for information regarding tests of the gravel and the geology of the deposits.

HISTORY

In early operations a small dragline machine was used to remove the overburden and then to excavate the sand and gravel and load it on standard-gage railroad cars. The material was used for railroad ballast, but the demand for other uses grew so rapidly it was soon necessary to increase production, and the present plant is the result of a gradual development brought about by the necessity of producing various special grades ot sand and gravel.

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[1] - The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6537."

[2] - One of the consulting engineers, U. S. Bureau of Mines.

DESCRIPTION OF DEPOSITS

The sand and gravel deposits, which lie in the immediate vicinity of Dallas and in close proximity to the Trinity river and its tributaries, are quite similar in character and as a general rule are all more or less subjected to overflow of flood waters.

The deposits were derived from the disintegrated and broken fragments of the hard limestone and sandy formations of the Commanche and Carboniferous rock to the west. Their origin is proved conclusively by the character of the constituents and by the fossils found in the deposits.

Unquestionably these materials were worked downstream, largely by flood waters, to form these gravel deposits, and the materials while in transit were not only rounded by abrasion but were to a considerable extent segregated by size in the swift currents, so that from point to point it is noticeable that the pebbles and grains of sand differ in shape as well as in size. Often the dividing line between two or several adjoining deposits is remarkably well defined.

The Trinity river flowed over many different outcrops of rock, with the result that the amount and kind of materials contributed to the stream load have differed. This is exemplified by the difference between the upland gravel deposits and those found in the present flood plain of the river.

The upland gravel deposits are not as valuable as the flood-plain deposits as they carry great quantities of foreign materials, such as clay, mud, soft limestone, chalk pebbles, etc., well mixed with rather poor grades of sand and gravel. However, the raw material from these deposits makes excellent driveways or country roads where traffic is light, due to the natural binders contained in the gravel.

The flood-plain deposits where proved to contain material of sufficient quality and quantity to justify exploitation on a large scale are very valuable. They are usually free from foreign material such as soft limestone, chalk pebbles, mud, clay, and silt and therefore may be mined and made into a finished product with a minimum of expenditure.

Gravel deposits in this locality, and, for that matter, throughout northeastern Texas, are small, usually not exceeding 40 or 50 acres in area and averaging 20 to 25 acres. However, a number of these deposits are often found close together. The deposits are also comparatively shallow. The upland deposits have practically no overburden and are from 3 to 5 feet thick, whereas the flood-plain deposits are covered with 8 to 12 feet of soil and clay overgrown with trees and brush, and very from 8 to 20 feet in thickness. The deposits are usually underlaid with a hard blue shale or a stratum of solid limestone. However, in many cases the base of the gravel beds is a hard clay.

The beds themselves are composed of silica and limestone in the form of sand and pebbles both of which are uniform in texture throughout. The sand is angular and hard, and the pebbles are also hard, well formed, and of the right size for a number of uses.

PROSPECTING AND EXPLORATION

Locating gravel deposits on the upland, is a comparatively simple matter as the gravel sometimes outcrops or is usually detected in the soil within a few inches of the surface, or is exposed in gully washes along the banks of small streams that drain the high ground. Often the upland deposits are found accidentally in digging post holes.

Locating gravel deposits on the flood plains is more difficult, as the gravel is covered by 8 to 12 feet of clay and soil and prospecting is expensive as the clay is both hard and deep. Further, commercial deposits are seldom discovered, even though a prospector may spend months in sinking holes with a boring machine or digging prospect shafts.

When a deposit has been located, it is usually explored by means of test pits dug by hand to the top of the gravel. If the pit is dry, hand digging may be continued through the deposit. Where this method is used, one man to a hole is all that is necessary for the first 7 feet of depth. From this on, there are two men to the hole, which is usually 3 by 5 feet in cross section through the overburden.

One man on the surface lays a plank across the hole to stand on and uses a 1-inch rope (large enough to keep from burning the hands while gripping it), to hoist a steel bucket that holds about ½ cubic foot of gravel.

The man in the hole, digs and loads material into the bucket. When the surface of the gravel deposit has been reached, it is well to change from a 3 by 5 foot oblong hole to one that is round and about 3 feet in diameter. If the gravel is not too loose, the man in the hole will be safe in going down in the gravel to a depth of 10 to 12 feet, or to 20 to 25 feet below the surface. Should the gravel be extremely loose, a specially constructed steel curb, in sections, should be used for the protection of the man in the hole.

One gravel company in this vicinity has a boring machine, similar to a post-hole auger on a large scale, that is mounted on and operated by a Fordson tractor. This machine bores a hole about 16 inches in diameter through the clay overburden at the rate of 1 foot to 5 feet per minute, depending on the hardness of the clay; and in case the hole caves, the auger can be pulled by reversing the direction of rotation.

The machine drills in clay to a depth of about 18-feet without difficulty, but it does not work so well in the gravel because of the continual falling of pebbles, which causes many cave-ins. For this reason drilling is stopped immediately upon striking the gravel, and the hole is continued by using a small orange-peel bucket, operated by hand, inside a 14-inch steel casing. This is a good outfit for working in loose gravel above the water line. When the water is struck, faster progress may be made by using a flap-valve bailer (bailing bucket used in bailing oil wells, or other deep wells). The bailer used for sinking through gravel under water is operated inside of a 10-inch pipe. It is usually 8 inches in diameter and is fitted on one end with a 3-pronged, hard-tempered cutting edge. Should the bailer be operated by hand, it should not be more than 2 feet long; as many as 8 men, working 6 at a time, will be needed to make the best progress.

The bailer is suspended from a light derrick, mounted on a sled, and is worked up and down by a 1-inch rope running through a pulley at the top and one near the base. The derrick on the sled is moved by team, tractor, or by the crew of 8 men.

The bailer when used on a self-moving well-drilling machine of the cable type, has proved successful in testing gravel deposits which lie below the water. Two men can operate this equipment to good advantage, and they can usually drill from 70 to 80 feet in 10 hours.

The gravel deposits near Bois D'Arc, now being worked by the East Texas Gravel Co., are typical flood-plain deposits with all the peculiar characteristics so noticeable in the many other similar deposits lying close to the Trinity River which are being worked by other operators.

The East Texas Gravel Co.'s deposits cover several hundred acres and the overburden of clay ranges between 4 and 12 feet. The sand and gravel have a depth of from 10 to 15 feet. The pit-run material averages about 45 per cent sand and 55 per cent gravel, and is fairly clean. The deposit lies below the normal water level which comes up to the base of the clay overburden.

The materials, both sand and gravel, in these deposits, are of exceptional quality; being free from mud, clay, soft limestone, chalk pebbles, etc., and particularly free from a medium-soft white limestone pebble which is mixed in small amounts with the sand and gravel from pits some 50 miles further up the Trinity River. The sand is angular, coarse, and hard, and is prepared by washing and sizing so that it meets practically all specifications, especially for concrete construction of different kinds.

The gravel is hard and tough, and particularly well adapted, because of size and quality, to use in concrete structures such as building columns, side walls, floor slabs, and all kinds of highway-drainage structures. It also fully meets specifications required by the Texas Highway Department and Federal engineers for the construction of concrete slabs and hard-surface tops of permanent highways.

The gravel and sand are thoroughly washed and rinsed, and sized to meet specifications for many different projects.

Only a small percentage of the gravel exceeds 3 inches in size, and for this reason no crushing is necessary. All of the oversize is sold to the railroads, or to contractors who do their own crushing on special jobs.

A screen analysis on an average sample of washed sand for concrete is as follows:

	Screen Inch	Per cent
On	½	00.0
On	¼	18.0
Through	¼	82.0
Total		100.0
	Mesh	
On	10	33.6
On	20	54.2
On	30	76.6
On	40	89.2
On	50	95.6
On	60	97.2
On	80	97.9
On	100	98.2
On	200	98.3
Through	200	1.7
Total		100.0

An analysis of an average sample of washed gravel for concrete is as follows:

	Screen Inch	Per cent
On	2	00.0
On	1½	1.5
On	1¼	7.1
On	1	19.1
On	¾	45.3
On	½	72.7
On	¼	94.6
Through	¼	5.4
Total		100.0
	Mesh	
On	10	99.5
On	20	.5
Total		100.0

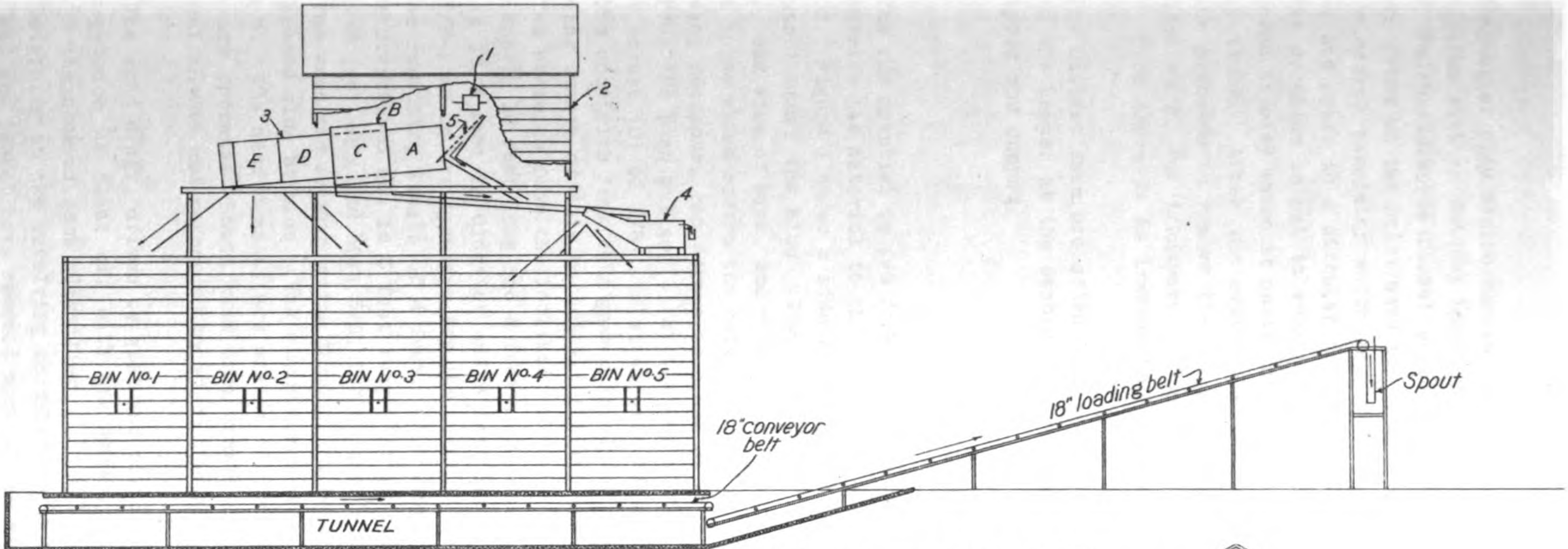

Figure 1.- Side elevation of bins and loading conveyor belt with longitudinal section of tunnel

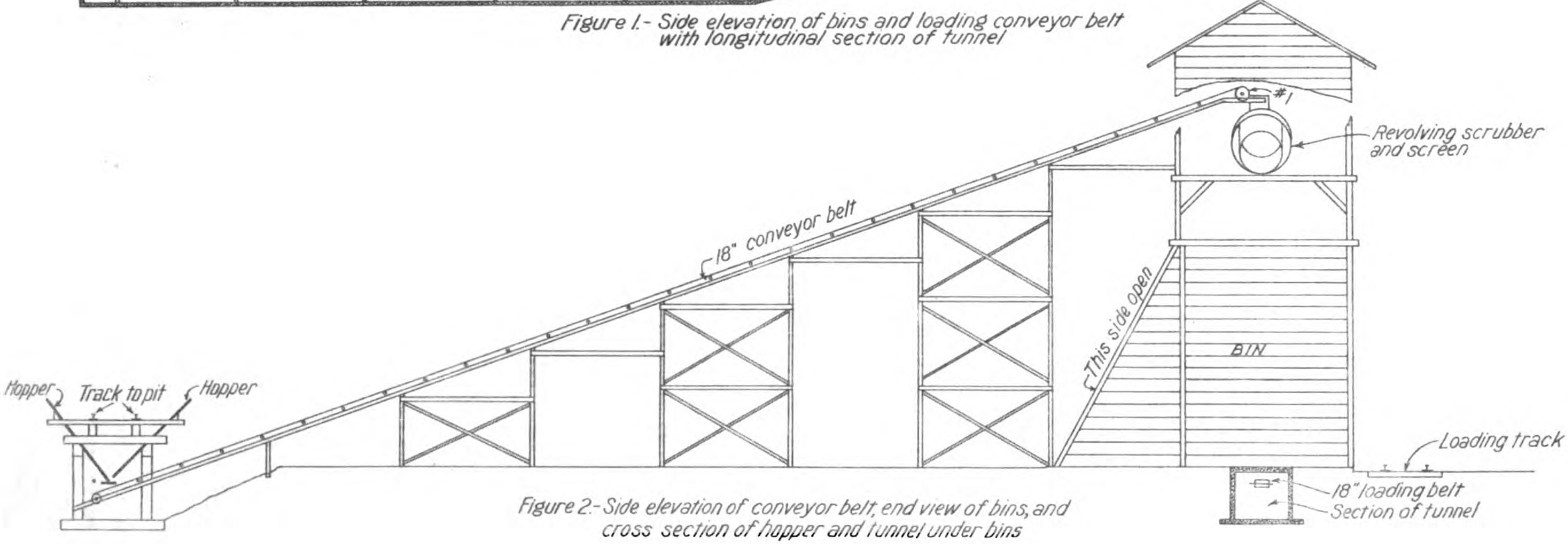

Figure 2.- Side elevation of conveyor belt, end view of bins, and cross section of hopper and tunnel under bins

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STRIPPING AND MINING

Removal of clay overburden and excavation of raw pit gravel is done by a Monighan walking dragline with an 85-foot boom and a 3-cubic yard bucket. This machine is powered by a 175-hp. Fairbanks-Morse Diesel engine belted directly to a shaft with clutches connecting with two drums on the hoist used for dragging and hoisting the bucket. There is also a belt to an electric generator which supplies current for a 50-hp. motor directly connected by pinions and gears to a circular rack for swinging the machine.

The dragline is put to work at any desired location in the pit, and first removes the overburden of clay which it casts to one side, usually at about 90° from the direction of the loading truck. After the overburden has been removed from about 5,000 square feet, the dragline proceeds to remove the pit gravel and places it in standard-gage, bottom-dump, 50-ton steel cars, for transport to the Texas and New Orleans Railroad Co.'s track to Bois D'Arc. From there it is transported to designated points along the main line and used for ballast.

The ballast cars are often utilized for transporting the pit gravel as loaded by dragline to the hopper at the washing plant. The ballast cars are spotted, one at a time, over the hopper and dumped.

SCREENING PLANT

The raw material is fed from the hopper by a plate feeder on to an 18-inch belt conveyor that carries the material to the top of the washing plant over a head pulley shown in Figures 1 and 2. Figure 1 shows a side elevation of the washing plant and a longitudinal section of the tunnel under the bins. Figure 2 shows a side elevation of the conveyor belt from the hopper, end view of bins, and cross section of hopper and tunnel under bins. The top portion of the house which covers the belts and electric motors that drive the 18-inch conveyor belt, revolving scrubber, and screen is shown at 2, Figure 1.

From the head pulley (1) at the top of the plant the pit gravel is sluiced over an inclined screen (5) of 1/8-inch steel wire having 3/8-inch square openings.

The undersize from this goes directly to the two sand classifiers (4) thus relieving the revolving screen of this burden and thereby speeding up production.

The oversize from the inclined screen is flushed into the revolving scrubber and screen (3) which is 18 feet long and 4 feet in diameter, and is surrounded midway by a wire jacket, B, that is 6 feet in diameter and 9 feet long. The jacket is made of 1/8-inch steel wire with 3/8-inch square openings for the first 5 feet of its length and 1/2-inch square openings for the remaining length of 4 feet. The scrubber portion of the revolving screen A, is on the receiving end and is 5 feet long. It is followed by sections C, D, and E, which are 6, 4, and 3 feet long and have 5/8, 1-3/8, and 3-inch round perforations, respectively.

The sand and water passing through the screen jacket are sluiced to two sand classifiers (4), placed side by side. The classifiers wash, size, dewater, and deposit the sand in bins 4 and 5. The sand classifiers are of the box type, with long sloping necks in which sand drags are operated. Each sand drag consists of two parallel chains mounted on cast-steel sprocket wheels and connected by steel plates 3/8 inch thick, 5 inches wide, and 30 inches long.

The sand drags, driven by gear and pinion, agitate the sand and keep dirt, silt, etc., in suspension to float off with the water, while the sand is dewatered and dragged out through the neck of each classifier.

Returning to the revolving scrubber and screen, we find that the inclined screen ahead of it and the jacket have removed most of the sand and water, leaving only the pebbles to be screened into three sizes and chuted to their respective bins.

Referring to Figure 1, bin 3 is for pebbles that pass through a 5/8-inch ring and are retained on 3/8-inch square mesh opening. Bin 2 is for pebbles through 1-3/8 inches and over ½ inch. Bin 1 is for pebbles through 3 inches and over 1-3/8 inches. The different sizes may be loaded out individually into cars through the gates on the side of each bin, or may be remixed in any desired proportion in a trough immediately under the revolving screen and from there spouted directly to the cars on the loading track for shipment.

In many instances where it is necessary to be more particular about the proportions of the several sizes, mixing is accomplished by use of the loading belt as follows:

Underneath the bins as shown in Figures 1 and 2, there is a tunnel having a 7 by 7 foot inside cross section and running parallel with the longitudinal axis of the plant. At intervals along the roof of tunnel, which forms a portion of the bottom of the bins, there are gates spaced from 10 to 12 feet apart along the center line. An 18-inch conveyor belt traverses the entire length of the tunnel, and the flow from the bins onto the conveyor belt is regulated by adjusting the bin gates to produce any desired specification. Small hoppers straddling the conveyor belt are placed beneath the various bin gates to guide the discharge.

After passing out of the tunnel the gravel is discharged onto another conveyor belt which rises to a point high enough to permit spouting the material over an inclined screen where it is sprayed with water with sufficient force to thoroughly rinse off the gravel before it is finally placed in the car for shipment.

Using the small dragline machine at the washing plant to stack pea gravel and sand in stock piles, as well as to reclaim it and load it out quickly, has been found to be a most advantageous method. When the sand and pea gravel have been stocked in piles near the washing plant to the capacity limit of open storage, the handling and rehandling of these materials eventually became a problem, for in addition to being hauled to the plant and carried through the regular process of being washed it was necessary to load them from bins to cars or from storage to cars and finally to dispose of them by dumping as waste somewhere along the line.

At first this was not a bad arrangement, as these materials when mixed make an excellent track ballast, and were utilized for this purpose. However, when all the track had received an adequate amount of this ballast, the continued dumping of these materials became not only a problem of finding a place to dump them, but also an expensive operation.

The disposal of the pea gravel and excess sand eventually became an acute problem and a method was worked out to dispose of all undesirable materials at the pit by removing them from the desirable materials and discharging them as waste into the pond formed by previous workings.

This method utilizes a portable loading and washing platform loaded by the Monighan walking dragline for eliminating the undesirable materials, such as large stones and big chunks of clay or mud, etc., as well as pea gravel and sand that is overabundant in the pit gravel.

Large stones and big chunks of mud and clay are removed from the platform by hand, and the sand and pea gravel are washed away by water that sluices them through an inclined screen and thence by flume back to the excavated areas of the pit. The oversize on the inclined screen rolls into standard-gage steel ballast cars for transport to the washing plant. This method of treatment eliminates the haul on waste material, relieves congestion at the plant and speeds up production of those products for which there was a ready market.

Figure 3 shows how the portable platform is constructed.

It may be seen that the standard-gage ballast cars pass under the platform, and that the floor of the platform slopes two ways, toward the center and also toward an inclined screen at one end. The raw pit gravel is placed directly by dragline onto the platform floor, which is covered with 10-gage steel plates laid in "rainproof" fashion.

Across the inclined screen and some 18 inches above it, several 3-inch pipes are placed, each perforated on one side with ¼-inch holes about 1-inch apart, through which water under pressure is sprayed on to the screen.

When the raw pit gravel is placed on the platform the water which is played on it through a small hydraulic giant floods the gravel and sand down grade to the inclined screen which has a pitch of about 45°. This pitch is sufficient to make the oversize roll off into the car while the sand and pea gravel are washed through the screen by the force of the water sprays to be flushed through a flume, made up of 25-foot portable sections, to the worked-out portion of the gravel pit where it may be picked up again on the next pass with the dragline or left as waste along with the overburden.

To move the portable platform, four timbers each 8 by 8 inches by 12 feet, a few blocks each 8 by 8 inches by 2 feet, and two good track jacks, are required to raise and block it upon one of the ballast cars. A special pocket was built into the portable platform to hold the timbers, blocks, and jacks so that they are always available when needed.

One of the ballast cars is used for a moving van, so to speak, by spotting it on the loading track directly under the platform. The four timbers are then placed across the car, two at each end of the platform immediately under the horizontal cross timbers of the platform that are about 18 inches above the top of ballast car. Both jacks are set, and one end of the platform is raised and blocked on top of the car, leaving its legs at that end some 8 inches or so above the foundation blocks. In like manner the other end of the platform is raised and blocked and the whole structure, then clear of all foundation blocks and resting on the ballast car, may be moved by the locomotive to a new location for further use or it may be taken to the end of the loading track to remain completely out of the way until it is again needed.

Water for use on the portable platform is plentiful, there being 10 or more feet of it standing in the pit at all times. A 6-inch centrifugal pump powered by a 30-hp. gasoline engine is used to pump the water through a 6-inch pipe to the top of the platform. The centrifugal pump and gasoline engine remain more or less stationary, but the 6-inch pipe laid parallel to and about 10 feet away from the track, is shifted each time the loading track is moved over for the new pass of stripping and loading.

SUMMARY OF COSTS

Period: July, 1929 to July, 1930.
Total material loaded during period:
Overburden, 110,000 cubic yards moved by dragline into pond formed by previous workings.
Sand and gravel, 123,500 tons.

Operating costs per ton of sand and gravel mined

	Labor	Supervision	Power	Fuel	Other supplies	Total
Operating costs:						
Stripping	$0.025	$0.002	-	$0.010	$0.022	$0.059
Mining and loading	.049	.005	$0.002	.002	.051	.109
Transportation	.032	.001	-	.014	.002	.049
Washing, screening and loading	.080	.010	.002	-	.003	.095
Storage	.005	-	-	.001	.005	.011
Repairs and maintenance	.020	.001	-	-	.110	.131
Miscellaneous	.006	-	-	-	.005	.011
Total	0.217	0.019	0.004	0.027	0.198	0.465

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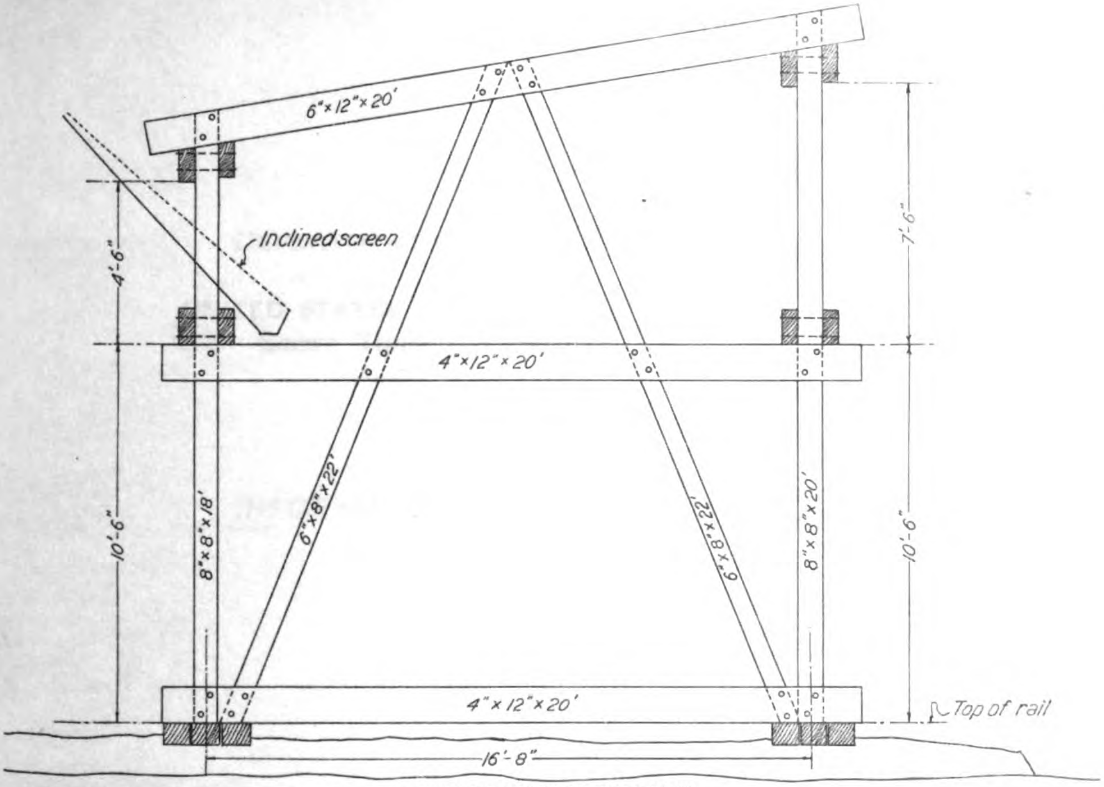
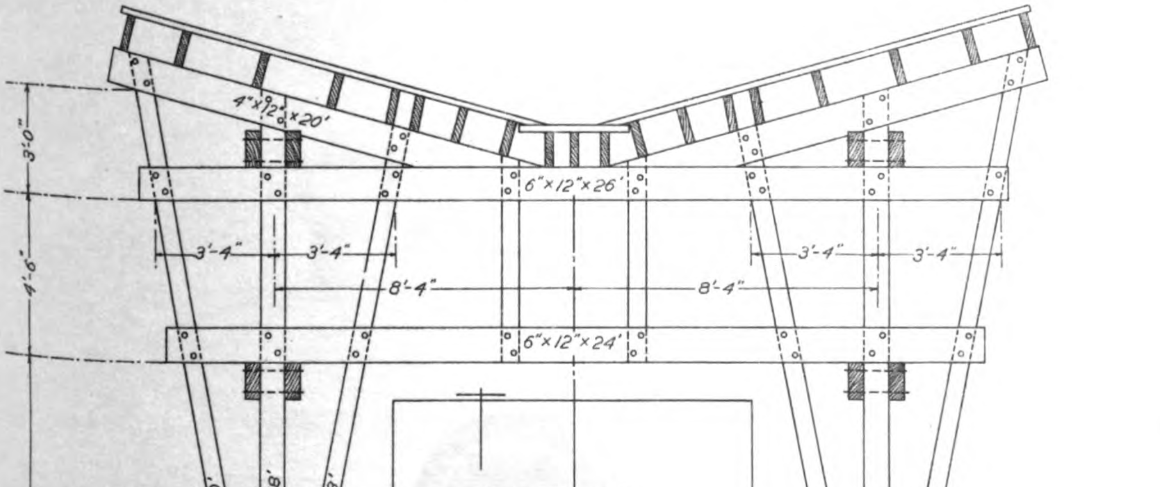


LONGITUDINAL SECTION



CROSS SECTION

Figure 3.- Portable platform